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ABSTRACT

The purpose of this project was to evaluate the effectiveness of an interactive Level 1 videodisc program called "Mastering Fractions." The evaluation was conducted in two parts. Part 1 was a controlled study that compared the Mastering Fractions program to a more traditional fractions curriculum while controlling for any novelty effect of the videodisc medium. Part 2 of the evaluation was a descriptive study that examined the use of "Mastering Fractions" in non-experimentally controlled classroom environments. Both in Part 1 and Part 2, all students were given a 69-item pre- and posttest that examined the learning objectives from a basal series math curriculum and the Mastering Fractions program. The use of the videodisc program resulted in gains in fractions skills and concepts. The results of structured interviews with both teachers and students indicated that the program was received very positively. Appendices include: (1) "Introduction to Interactive Videodisc"; (2) "Pre-Posttest"; (3) "Mastery Tests"; (4) "Teacher Logs"; (5) "Teacher Structured Interview Questions"; and (6) "Student Structured Interview Questions." Lists 4 references. (Author/YP)

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AN EVALUATION OF THE MASTERING FRACTIONS
LEVEL-ONE INSTRUCTIONAL VIDEODISC PROGRAM

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An Evaluation of the Mastering Fractions
Level-One Instructional Videodisc Program

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Abstract

The purpose of this project was to evaluate the effectiveness of an interactive Level 1 videodisc program called "Mastering Fractions." The evaluation was conducted in two parts. Part 1 was a controlled study that compared the Mastering Fractions program to a more traditional fractions curriculum while controlling for any novelty effect of the videodisc medium. Part 2 of the evaluation was a descriptive study that examined the use of Mastering Fractions in non-experimentally controlled classroom environments. Both in Part 1 and Part 2, all students were given a 69-item pre and posttest that examined the learning objectives from a basal series math curriculum and the Mastering Fractions program. The scores on the pre and posttests were used as a dependent measure in the evaluation. In addition, all teachers and a sample of the students were given structured interviews at the completion of the evaluation. These qualitative data were used as a measure of the teachers' and students' attitudes toward the Mastering Fractions program.

Part 1. This part of the evaluation was conducted in the Nashville Metropolitan Public School System, Nashville, Tennessee. Three treatment conditions were compared. A control condition that consisted of the fractions curriculum being used by the Metro School System. The second condition consisted of the Mastering Fractions program without the use of the videodisc. In this condition the teachers emulated the Mastering Fractions disc

as closely as possible using an overhead projector for presenting information to the students. In the third condition, the teachers used the Mastering Fractions program as it was designed to be used. A high-achieving and average-achieving class was assigned to each of the three treatment conditions. A 3x2 ANCOVA was used to determine if differences existed between the treatment conditions and the ability groups.

The results of the ANCOVA indicated that significant differences existed between the three treatment conditions. Follow-up Sheffe tests indicated that students receiving the Mastering Fractions videodisc and the teacher-emulated Mastering Fractions treatments scored significantly higher than those students receiving the Metro Nashville fractions curriculum. However, there was no difference between the two Mastering Fractions conditions. This finding suggests that the achievement gains found in these groups can be attributed to the instructional content of Mastering Fractions program and not attributed to any novelty effect produced by the videodisc medium.

Part 2. In Part 2 of the evaluation the Mastering Fractions program was placed in three school systems representing both urban and rural settings. The school systems chosen to participate in the evaluation included: Ashville City Schools, Ashville, North Carolina; Avery County Schools, Avery County, North Carolina; and Lauderdale County Schools, Lauderdale County, Alabama. From the three school systems, seven classes were

selected to participate. The classes ranged from the fifth through the ninth grades. A total of 143 students were included in the evaluation.

Dependent measures for Part 2 of the evaluation were the same as those in Part 1. A repeated-measures t test was used to determine if students made significant gains from the pretest to posttest period. Results of the analysis showed that five of the seven classes made significant gains at the .01 level and the remaining two classes made gains at the .05 level of significance. In addition to the t tests, an ANCOVA was conducted on the posttest scores for all seven participating classes. The results indicated that significant differences existed between the classes even after the posttest scores had been adjusted for individual student differences. This would suggest that the Mastering Fractions program is not teacher-proof and its effectiveness is influenced by teacher differences.

Summary. The results of the two-part of the evaluation support several conclusions. First, the use of Mastering Fractions videodisc program results in significant gains in fractions skills and concepts. Second, the use of the Mastering Fractions videodisc produces the greatest gains when used as Designed, differences in teacher implementation effect student achievement. Third, the Mastering Fractions program was found to be more effective than the existing fractions curriculum being used in the Metro Nashville Public School system.

The results of the structured interviews with both the teachers and students indicated that the Mastering Fractions program was received very positively. Students indicated that they enjoyed learning fractions using the videodisc more than traditional instruction and all of the teachers indicated that they would recommend the use of the Mastering Fractions program to other teachers and that they would continue to use the Mastering Fractions program in the future.

INTRODUCTION

The following report describes an evaluation on the use of an instructional videodisc program for teaching fractions. The evaluation was conducted by the Learning Technology Center, Peabody College of Vanderbilt University, under a contract from the Tennessee Valley Authority. The primary purpose of the evaluation was to determine the effects of the Mastering Fractions instructional videodisc program (Systems Impact, Inc., 1986) on student achievement in fractions. A secondary purpose of the evaluation was to evaluate teacher and student attitudes toward this instructional program.

Problems with Instructional Media Evaluations

Over the past decade, much of the research examining instructional technology has attempted to isolate the influence of various media on learning by comparing the relative achievement of learners who have received similar subject matter from different media. For example, a large number of researchers have simply compared the effects of media delivered instruction (i.e. T.V., computer, videotape) with more traditional teacher delivered instruction, however, most of these media comparison studies have failed to control for instructional content and methodology.

Recently, a number of researchers have challenged the fruitfulness of simple media comparison studies for determining the effect of technology on learning. For example, even in cases where dramatic changes in achievement or ability have followed the introduction of a medium, as was the case in a study by Schramm (1977), it has been argued that it was not the medium that caused the change but rather a curricular reform that accompanied the change. Clark (1983) has argued convincingly that instructional technologies are "... mere vehicles that deliver instruction but do not influence student achievement any more than the truck that delivers our groceries causes changes in our nutrition" (p.445). Clark has suggested that the positive outcomes attributed to learning from media are as likely to be the effects of novelty, or the effects of different instructional methods and curriculum content used by the technology and the comparison teacher. Further, Clark suggested that future research should focus on the instructional content and not the medium itself since it is the instructional methodology that is the important variable in determining the effectiveness of the instructional product.

Although the stated purpose of this evaluation was to determine the effectiveness of a Level 1 videodisc program for teaching fractions, the media (i.e. videodisc) was not the primary target of the evaluation. Rather, the focus of the

evaluation, as several researchers have suggested, was to determine the effectiveness of the underlying instructional methodology since the videodisc medium is simply the medium for transporting the instructional program. Thus, this evaluation was conducted in two parts. Part 1 was an experimental study that examined the effectiveness of the pedagogical methodology underlying the instructional program apart from the videodisc medium. Part 2 of the evaluation was a descriptive investigation of the effectiveness of the videodisc program when placed in a natural instructional setting. By combining the results from the two parts of this evaluation, educators gain valuable insight into the effectiveness of the instructional methodology and how this methodology can be transported into the classroom through the use of technology.

METHODS AND RESULTS

In the following section a description of the materials and dependent measures that were common to both Part 1 and Part 2 of the evaluation will be described. This will be followed by a separate description of the Procedures and Results for the two parts of the evaluation.

Mastering Fractions Interactive Videodisc: A Description

As previously stated, the purpose of the project was to evaluate the effectiveness of an interactive instructional

videodisc program called "Mastering Fractions". Readers generally not familiar with the videodisc medium, or those unfamiliar with the classification scheme used to define the levels of videodisc interactivity, are referred to Appendix A.

The Mastering Fractions program is a Level 1 interactive videodisc program that is a part of the Core Concepts videodisc series produced by Systems Impact, Inc. (1986). The scope and sequence of the Mastering Fractions Program covers the following instructional objectives:

1. Discriminating whether fractions are more than, less than, or equal to one.
2. Decoding fractions so they are understandable on the number line or as diagrams.
3. Writing whole numbers and other values as fractions.
4. Generating equivalent fractions.
5. Ranking fractions by size.
6. Rewriting whole numbers on number lines as fractions.
7. Rewriting fractions as mixed numbers.
8. Simplifying fractions.
9. Multiplying fractions by fractions and whole numbers.
10. Adding and subtracting fractions with unlike denominators.
11. Rewriting mixed numbers as fractions.
12. Dividing fractions.

The Mastering Fractions instructional package consists of three

double-sided videodiscs, an Instructor's Manual, and Student Response Booklets. The three double-sided discs contain 35 lessons that include mastery tests, quizzes, reviews, and remedial exercises. The equipment needed to use the Mastering Fractions Program includes a videodisc player (home or commercial model) with remote control unit, and at least one 19 inch color video monitor (25-inch monitors are preferable).

Instructor's Manual. The Instructor's Manual is divided into nine parts: an overview of the Mastering Fractions program and equipment needed, a description of course content, instructions for using the videodisc equipment, teaching procedures, rationale and instructional features of the package, a glossary, index for disc lessons, placement tests, and answer keys.

Student Response Booklets. Student Response Booklets are consumable and are coordinated with each videodisc lesson. The daily worksheets typically present between 25 and 35 problems and can be completed in 15 to 20 minutes. Teachers are encouraged to grade each lesson's worksheets before moving on to new lesson and to give the students feedback on any mistakes. The worksheets also provide the teacher with information about misconceptions or errors the students may be exhibiting.

Placement tests. A ten-item placement test may be administered before the introduction of the program to identify

students who should not be placed in the program or to provide baseline data for student improvement. The developers suggest that students missing no more than two items on the placement test do not need the Mastering Fractions program. Those missing three or more items are candidates for the program.

Computation Skills. The Placement Test described above covers only fraction skills. If students have not mastered basic addition, subtraction, and multiplication skills they should not be placed in the program. If there are questions about a student's basic math skills, the 20 item multiplication quiz provided with the Mastering Fractions Instructor's Manual should be administered. The time limit for the test is one minute and 30 seconds. Students should make no more than two errors, including items not responded to. If the criterion is not met the developers suggest that the students should practice multiplication facts until the above criterion is met.

Instructional methodology. The instructional methodology underlying the Mastering Fractions program can be summarized by six fundamental instructional functions identified by Rosenshine and Stevens (1986), these include:

1. Review (check previous day's work and reteach, if necessary)
2. Present new content/skills

3. Guided student practice (and check understanding)
4. Feedback and correctives (and reteach, if necessary)
5. Independent student practice
6. Weekly and monthly reviews. (p.379)

Each Mastering Fraction lesson follows these six fundamental instructional functions. The typical lesson begins with a paper and pencil quiz on the concepts presented the previous day. The quiz consists of a series of still frames shown on the video monitor. Five to ten problems are shown and at the end of the quiz the answers are given and the students check their work. The teacher then evaluates the classes performance on the quiz. If 80% of the class successfully answers the quiz questions then they move on in the lesson. If less than 80% were successful, then the teacher goes through a remediation sequence before proceeding through the lesson.

Each instructional sequence in the Mastering Fractions Program is characterized by a lively presentation of a fractions concept by a narrator/actor. Pacing throughout all instructional lessons is brisk with ample opportunity for the students to respond to prompts by the narrator. Excellent graphics and sound are used to visually and auditorily present concepts being taught.

The instructional sequence of the lesson begins with a short review of previous concepts by a narrator. The students are asked to orally answer the questions posed by the narrator in the

videodisc lesson. There is a pause in the program for responses. At any time the teacher may stop the video sequence to allow additional time for responding. At the end of the review the teacher may choose to remediate by taking the students through a remediation sequence on the videodisc that corresponds with the current concept, or if no remediation is needed, the teacher continues the videodisc lesson.

The students use paper and pencil throughout the lesson for solving problems presented to them during the videodisc instruction. The students divide their paper into two equal halves by drawing a vertical line down the page. On the left side the student writes the problems and answers. The right side is used for correcting any errors. The students are encouraged to correct errors by recopying the missed problem and writing the correct answer. Dividing the paper with a vertical line makes it easier for the teacher to see which problems the students are having difficulty with and allows the teacher to do some monitoring of student progress. The paper and pencil activity is also used for all remediation sequences.

At the end of each lesson the students are assigned practice problems in the Student Response Booklets. The lessons in the booklet correspond to the lessons presented on videodisc. There are 25 to 35 questions per lesson. Teachers are encouraged to grade the practice problems before going on to the next videodisc

lesson.

At the end of every four teaching lessons a Mastery Test is administered. Each test is divided into parts covering a specific skill. Test Summary forms are provided to aid the teacher on where remediations are needed within each lesson. After all needed remediations have been administered, the teacher may move on to the next lesson.

The Mastering Fractions Program contains a total of 35 lessons. Twenty-eight instructional lessons and seven test lessons occurring after every four teaching lessons. The instructional lessons take between 30 and 50 minutes to complete without remediation. Presenting tests and remediations take between 15 and 40 minutes depending on the performance of the students. Ideally, the 35 lessons should be presented one per class period. Thus if used consistently, the entire Mastering Fractions program can be completed easily in seven to nine weeks.

Dependent Measures

Pre-Post Test. The pre-post test was developed from the Mastering Fraction objectives and a scope and sequence chart for fractions from a sixth grade math basal series. A sixty-nine item test was developed that included test items measuring each

of the 12 objectives covered in the Mastering Fractions program as well as those fraction skills listed in the basal scope and sequence chart. All students participating in the evaluation (Part 1 and 2) were tested prior to the beginning of the evaluation and again at the end of the study. A copy of the pretest/posttest is found in Appendix B.

Mastery tests. After every four lessons in the Mastering Fractions program a mastery test is given. The two page test reviews information taught in the previous lessons. Copies of the seven mastery tests can be found in Appendix C.

Values for coefficient Alpha were calculated on the pretest, posttest, and the seven mastery tests. As shown in Table 1, all of these tests had high Alpha coefficients indicating a strong internal consistency. This finding would suggest that the tests were measuring a single or small group of related constructs and are reliable dependent measures.

Teacher logs. Teachers were required to keep daily logs on the use of the Mastering Fractions program. In these logs teachers recorded information such as: number of minutes they spent in preparing for each lesson; number of minutes spent grading homework; number of minutes to complete the lesson; and comments on the effectiveness of the lesson. These logs were mailed to the project coordinator on a weekly basis. A copy of

Table 1

Alpha Coefficients for the Pretest, Mastery Tests, and Posttest

	Variables	Mean	SD	Alpha
Pretest	69	36.03	12.23	0.93
Mastery Test 5	28	26.58	2.34	0.80
Mastery Test 10	30	28.18	2.54	0.77
Mastery Test 15	19	17.28	2.05	0.68
Mastery Test 20	16	14.50	2.06	0.74
Mastery Test 25	21	18.44	3.65	0.88
Mastery Test 30	9	7.91	1.94	0.84
Mastery Test 35	17	11.47	4.84	0.90
Posttest	69	52.52	10.98	0.93

the log sheet is found in Appendix D.

Teacher Interviews. Following the evaluation, all of the teachers participating in the study were given a structured interview by one of the project staff. The purpose of the interview was to gain information that may have been omitted from the daily logs and to get an overall impression from the teachers about their feelings concerning the Mastering Fractions program. Interviewers used a set of predetermined questions to help structure the interviews, however, the interviews were not constrained by these questions. Although all questions were covered in an interview, both the teachers and interviewers were free to discuss any issue concerning the use of the Mastering Fractions program. A copy of the interview questions can be found in Appendix E.

Student Interviews. In addition to interviewing all teachers who participated in the evaluation, a randomly selected set of students were also interviewed. Four students were selected from each class participating in the evaluation. The students were stratified on sex so that an equal number of males and females were interviewed. As with the teacher interviews, a set of predetermined questions were used to structure the interview but the interviews were not constrained by the questions. A copy of the questions used during the interviews can be found in Appendix F.

Part 1: Experimental Study

Part 1 of the evaluation was an experimental study that attempted to factor out any novelty effect attributed to the videodisc medium of the Mastering Fractions program before comparing its effectiveness to another instructional medium. As pointed out by Clark (1983), a technological medium is merely a vehicle for delivering instruction, if instruction is poorly conceived, a medium cannot overcome the instructional inadequacies. In this study the content of the Mastering Fractions program was compared using two presentation formats, a) videodisc, and b) a teacher using overhead transparencies. These two conditions were then compared to a third teacher presented curriculum that served as a control condition. Following is a description of the methods and results of the experiment.

Subjects

The experimental component of the evaluation was conducted in the Metropolitan Nashville Public School System, Nashville, Tennessee. The Metro Nashville system represents an urban school setting serving approximately 55,000 students. The classes selected for the study included four sixth-grade math classes from an intercity middle school. Two of the classes of were classified as high-ability and two were classified as

average-ability classes by the school system. A total of 83 students participated in the evaluation. The racial make-up of the subjects was 40% Caucasian and 60% Black.

Procedures

The study compared the effectiveness of the Mastering Fractions videodisc program with two contrast conditions. The first contrast condition was a teacher replication of the Mastering Fractions program. In this condition the teacher used all of the Mastering Fractions materials except the videodisc itself. The teacher attempted to emulate as closely as possible the instructional methodology presented by the disc. Thus, students in this treatment condition received the same instructional content as students in the videodisc condition, the only difference being that the Mastering Fractions content was presented totally by teachers using overhead transparencies and not by videodisc. By comparing the Mastering Fractions Videodisc condition with the Mastering Fractions Teacher condition it was possible to determine if the novelty of the videodisc had an effect on achievement outcomes.

The second contrast condition was also teacher presented. In this condition students received the fractions curriculum used by the Metro Nashville Public School System. The Metro fractions curriculum is a spiraling curriculum where the students receive

fractions instruction several times throughout the year, with each spiral through the curriculum building on previous instruction. The concepts being taught become more difficult with each spiral.

Two of the four experimental classes, one high-ability and one average-ability, were assigned to the Metro fractions curriculum and served as a control condition. The remaining two classes, one high-ability math and one average-ability, were randomly divided with half of each class being assigned to the Mastering Fractions Videodisc (MF-Video) condition and the other half being assigned to the teacher emulated Mastering Fractions (MF-Teacher) condition. Students were assigned to the Mastering Fractions conditions using a stratified random sampling procedure based upon pretest scores.

The students in the Mastering Fractions conditions received instruction three to four days per week. All groups received instruction for a total of 39 school days. Because instruction with the average-ability classes required additional time for remediations, these students completed only 25 of the 35 lessons before the end of the school year. The high-ability classes, however, completed all 35 lessons.

Following completion of the study all control and experimental students were posttested. In addition, four

randomly selected students from each of the Mastering Fractions classes were interviewed.

Analysis. A 3x2 analysis of covariance was used to determine if differences existed between the three treatment groups on the posttest. Analysis of covariance was selected as a means of testing for group differences in an effort to control for potential differences in pretest scores between groups. Additionally, by using predicted scores based on pretest, the procedure helps to mitigate against regression effects which frequently distort change score data. Finally, Scheffe's S Method was used to determine the source of the significant differences from the ANCOVA.

Results

Descriptive data describing the the pretest and posttest results for the three treatment conditions are shown in Table 2. The mean and standard deviation for the pre and posttest scores are given for the high and average-ability classes in each of the three treatment conditions. As can be seen in Table 2, students receiving the two Mastering Fractions treatments scored higher on the posttest than did the control students receiving the Metro fractions curriculum. Further, the overall gains from pretest to posttest were greater for the Mastering Fractions students.

Table 2

Mean, Standard Deviation, and Percent Correct on the Pretest
and Posttest for the Experimental and Control Classes

		MF-Video		MF-Teacher		Control	
		Pretest	Post Test	Pretest	Post Test	Pretest	Post Test
High-Ability	Mean	43.40	61.80	43.60	58.90	51.70	53.90
	SD	10.43	4.52	9.34	8.25	8.68	6.07
	n	10	10	10	10	20	20
Average-Ability	Mean	26.83	52.92	26.91	52.00	30.75	39.65
	SD	6.24	5.12	6.95	8.02	8.77	10.31
	n	12	12	11	11	20	20

Table 3

Comparison of Posttest Scores for
Experimental and Control Classes

	SS	MS	df	F
Covariate Pretest	2168.49	2168.49	1	48.01*
Treatment	2855.82	1427.91	2	31.62*
Period	63.81	63.81	1	1.41
Treatment X Period	113.60	56.80	2	1.26
Explained	5572.79	928.80	6	20.56*
Error	3432.63	45.17	76	
Total	9005.42	109.82	82	

* $p < .01$.

Table 4

Mean, Standard Deviation, and Percent Correct on the
Pretest, Posttest, and Mastery Tests for the Experimental Classes

		Pretest	Mastery Test 5	Mastery Test 10	Mastery Test 15	Mastery Test 20	Mastery Test 25	Mastery Test 30	Mastery Test 35	Post Test
High-Ability NF-Teacher	Mean	43.40	---	29.40	18.10	14.70	18.40	8.90	12.10	81.00
	SD	10.43	---	0.84	1.29	2.06	2.27	0.32	4.68	4.52
	n	10	--	10	10	10	10	10	10	10
	Percent	0.83	--	0.90	0.95	0.92	0.88	0.99	0.71	0.90
High-Ability NF-Videodisc	Mean	43.80	27.81	28.30	18.20	14.70	18.90	8.20	13.50	58.90
	SD	9.34	0.42	2.50	0.83	1.06	2.23	1.03	0.71	8.25
	n	10	10	10	10	10	10	10	10	10
	Percent	0.62	0.99	0.94	0.96	0.92	0.90	0.91	0.79	0.85
Average-Ability NF-Videodisc	Mean	26.83	25.98	27.75	17.42	14.42	19.25	---	---	52.92
	SD	6.24	3.15	2.49	1.98	1.18	1.91	---	---	5.12
	n	12	12	12	12	12	12	--	--	12
	Percent	0.39	0.91	0.92	0.92	0.90	0.92	--	--	0.77
Average-Ability NF-Teacher	Mean	26.91	25.83	27.08	17.42	13.87	17.50	---	---	52.00
	SD	6.95	2.29	2.81	1.56	3.26	4.22	---	---	8.02
	n	11	12	12	12	12	12	--	--	11
	Percent	0.59	0.92	0.90	0.92	0.85	0.83	--	--	0.75

NOTE: dashes indicate missing test data

To examine for differences between the posttest scores in the three treatment groups an analysis of covariance (ANCOVA) was conducted with the pretest scores being used as the covariate. The ANCOVA indicated that a significant difference existed between the three treatment conditions, $F(2,82) = 31.62, p < .01$. No differences were found for the ability level or treatment x ability level. The results of the ANCOVA are shown in Table 3.

A follow-up Scheffe test was conducted to determine the source of the significant difference from the ANCOVA. The results from the Scheffe indicated that the students in the Mastering Fractions Video and Mastering Fractions Teacher conditions scored significantly higher on the posttest than did students in the control condition, however, students receiving the Mastering Fractions treatments did not score significantly different from each other on the posttest.

Finally, data from the two Mastering Fractions treatments were analysed in terms of the percent of problems solved correctly on the pretest, posttest, and seven mastery tests. As shown in Table 4, on mastery tests 5 through 25, students in both treatment conditions scored over 80% correct with an average of 91.5%. There appeared to be a consistent but unexplained drop, however, in the percent of correct problems on test 35 for the high-ability group. This drop in performance was not evident in the posttest where the high-ability groups averaged 87.5%

correct. Although the average-ability groups scored below 80% on the posttest this should be expected since they did not complete the final 10 lessons.

The results of the data analysis form the basis for several conclusions. First, the achievement gains resulting from the use of the Mastering Fractions program can be attributed to instructional content and methodology. There appears to be little novelty effect as a result of the videodisc medium. Second, the Mastering Fractions program was more effective than the existing fractions curriculum used in the experimental school.

Part 2: Descriptive Study

The purpose of Part 2 of the evaluation was to examine the effect of the Mastering Fractions videodisc program on student learning in a variety of in situ settings. There was no attempt in this part of the evaluation to compare the Mastering Fractions videodisc program against any other instructional program. As Clark (1983) pointed out in his review on learning from media:

Based on consistent evidence, it seems reasonable to advise strongly against future media comparison research. Five decades of research suggest that there are no learning benefits to be gained from employing different media in instruction, regardless of their obviously attractive features or advertised superiority. All existing surveys of this research indicate that confounding has contributed to the studies attributing learning benefits to one medium over another and that the great majority of these

comparison studies clearly indicate no significant differences (p. 450).

Thus, the following study is a descriptive evaluation that examined learning outcomes when the Mastering Fractions videodisc program was used in a classroom setting. There was no attempt to compare the videodisc medium against other instructional media since instructional content and methodology could not be controlled in the field sites.

Subjects

Three school systems were selected by the Tennessee Valley Authority as field sites for evaluating the Mastering Fractions videodisc program. These sites were chosen based on demographic characteristics that were representative of school systems served by TVA. Geographic location and size of the school systems were the two primary criteria for selection.

The three sites chosen to participate in the evaluation included: Ashville City Schools, Ashville, North Carolina; Avery County Schools, Avery County, North Carolina; and Lauderdale County Schools, Lauderdale County, Alabama.

In Avery County, North Carolina a class of 28 ninth graders enrolled in a general mathematics class participated in the program. In the Asheville City Schools, four classes and three teachers participated in the evaluation. The Asheville classes

included one fifth grade with 14 students, two academically advanced sixth grade classes totaling 26 students, and one ninth grade general math class with 28 students. In Lauderdale County, Alabama, one class of 25 low average eighth graders in general math and one class of 22 ninth graders in general math participated.

Procedures

Prior to beginning the project, all teachers were given a one-day training session on the use of the Mastering Fractions program. Following training, each field site received one set of Mastering Fractions discs, an Instructor's Manual, and enough Student Response Booklets for each participating student.

The sixty-nine item pretest was given to all students participating in the evaluation. Following the pretest, teachers were instructed to use the Mastering Fractions program as described in the Instructor's Manual. All teachers were required to keep a daily log that described the use of the program. The log was returned each week by mail to the project coordinator so that progress through the Mastering Fractions program could be monitored.

Consistency of implementation varied across the field sites. Some teachers used the program on a daily basis while

others were much less consistent. Data showing the beginning and ending dates and the number of school days needed to complete the program are shown in Table 5.

As shown in Table 5, the teacher in Class 4 completed only 25 of the 35 lessons. The teacher reported that she elected not to complete all thirty-five lessons because the lessons were becoming too difficult for her class and that they were getting tired of the program.

After every five lessons the teachers administered a Mastery Test to the students. These tests were graded by the teachers, shown to the students, then mailed to the research coordinator for scoring verification and analysis.

At the completion of the Mastering Fractions program, all students were posttested using the same test that was used for the pretest. In addition, four students were randomly selected from each class for follow-up interviews and all participating teachers were interviewed.

Analysis. A one-way analysis of covariance was conducted on the posttest scores for the seven classes with follow-up post-hoc comparisons being conducted to determine the source of the significant differences. In addition, repeated measures t tests were conducted to test for significant gains from the pretest to posttest period for each of the seven classes.

Table 5
Number of Days Required to Complete the
Mastering Fractions Program in the Field Sites

Class	Beginning Date	Ending Date	Number of school days to complete 35 lessons
(1)	1/30/86	3/21/86	36 days
(2&3)	1/13/86	3/05/86	38 days
(4)	2/10/86	4/21/86	51 days (25 lessons)
(5&6)	1/14/86	3/21/86	48 days
(7)	1/9/86	4/22/86	73 days

Results

Data describing the pretest, posttest, and mastery tests for the seven classes are shown in Table 6. Four of the seven classes averaged 80% correct or higher on the posttest. Of the three classes that scored below 80%, Class 4 completed only 25 of the 35 lessons, and the teacher in Class 7 spread the instruction over 73 school days requiring almost twice as long as the more successful teachers to complete the instruction.

In order to determine if students made significant pretest to posttest gains a repeated measures t test was conducted on the pretest and posttest scores for each of the seven classes. The results of the analyses are shown in Table 7. The analyses revealed that all seven classes made significant pre to posttest gains. Classes 1, 2, 3, 5, and 6 made gains that were significant at the .01 level of significance and classes 4 and 7 made gains that were significant at the .05 level.

In addition to the pre-post t tests, an ANCOVA was conducted on the posttest scores for the seven field site classes with the pretest scores being used as a covariate. The results of the ANCOVA indicated a significant difference existed between the seven classes on the posttest, $F(6,129)=21.27$, $p<.01$. The results from the ANCOVA are shown in Table 8.

A follow-up Scheffe test was conducted to determine the source of the significant difference from the ANCOVA. The results from the Scheffe are shown in Table 9. As can be seen, 13 of the 21 possible comparisons were significant. These comparisons provide some generalizations. Classes two and three seem to form one group representing a high-achievement level. Classes one, five, six, and seven form a group representing medium achievement. Class four stands out as a lower achieving class. This points to the importance of the teacher as a significant factor in the effectiveness of the program. After adjusting for student differences, if no differences had been found between groups, it could be said that the program was implemented equally well by all teachers. This, however, was not the case. Some teachers implemented the program more effectively than others. While all students made significant gains in the pre-post analysis, there were differential effects across teachers.

Table 6

Mean, Standard Deviation, and Percent Correct on the Pretest,
Posttest, and Mastery Test for the Field Sites

		Pre Test	Mastery Test 5	Mastery Test 10	Mastery Test 15	Mastery Test 20	Mastery Test 25	Mastery Test 30	Mastery Test 35	Post Test
Class 1	Mean	42.54	27.00	27.54	17.46	13.62	16.92	8.38	10.42	55.00
	SD	8.38	1.82	2.11	1.67	2.62	3.82	1.24	4.36	8.37
	n	24	24	24	24	24	24.00	24	24	24
	Percent	0.62	0.96	0.17	0.92	0.84	0.81	0.93	0.61	0.80
Class 2	Mean	38.40	27.80	29.80	18.50	15.70	20.30	8.60	15.50	65.00
	SD	9.17	0.62	0.42	0.71	0.48	0.97	0.97	1.08	2.36
	n	10	10	10	10	10	10	10	10	10
	Percent	0.56	0.99	0.99	0.97	0.98	0.98	0.94	0.91	0.93
Class 3	Mean	26.93	27.00	28.93	17.13	14.80	19.80	7.13	12.73	59.93
	SD	10.16	1.07	1.10	2.00	1.74	1.36	1.98	2.25	4.50
	n	15	15	15	15	15	15	15	15	15
	Percent	0.39	0.96	0.96	0.90	0.92	0.94	0.88	0.75	0.87
Class 4	Mean	19.36	23.07	28.00	15.29	7.82	10.89	---	---	28.93
	SD	3.18	5.38	2.86	3.20	4.35	5.88	---	---	13.30
	n	14	14	14	14	11	9	---	---	14.00
	Percent	0.28	0.82	0.92	0.80	0.49	0.52	---	---	0.42
Class 5	Mean	28.28	26.80	27.60	16.72	14.72	18.72	8.04	10.92	47.40
	SD	8.63	1.98	2.02	1.51	1.44	3.74	1.24	4.61	10.13
	n	25	25	25	25	25	25	25	25	25
	Percent	0.41	0.96	0.92	0.88	0.93	0.89	0.98	0.64	0.69
Class 6	Mean	47.14	26.91	27.86	18.14	15.23	20.00	8.81	15.18	56.18
	SD	10.70	2.29	3.52	1.32	1.07	1.77	0.29	2.02	7.44
	n	22	22	22	22	22	22	22	22	22
	Percent	0.68	0.96	0.93	0.95	0.95	0.95	0.99	0.89	0.81
Class 7	Mean	31.90	24.20	28.55	16.30	13.70	16.05	5.80	6.55	41.10
	SD	10.85	3.50	3.28	3.29	2.64	5.03	3.00	5.42	11.29
	n	20	20	20	20	20	19	20	20	20
	Percent	0.46	0.86	0.95	0.86	0.86	0.76	0.64	0.39	0.60

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Table 7

Comparison of Pretest to Posttest Gains
for the Field Sites

		Pretest	Post Test	t
Class 1	Mean	42.76	55.28	9.15 **
	SD	8.28	8.31	
	n	25	25	
Class 2	Mean	38.40	64.00	10.03 **
	SD	9.17	2.36	
	n	10	10	
Class 3	Mean	26.93	59.93	13.52 **
	SD	10.16	4.50	
	n	15	15	
Class 4	Mean	19.36	28.93	2.92 *
	SD	3.18	13.30	
	n	14	14	
Class 5	Mean	28.28	47.40	10.40 **
	SD	8.83	10.13	
	n	25	25	
Class 6	Mean	47.14	56.18	6.87 **
	SD	10.70	7.44	
	n	22	22	
Class 7	Mean	30.63	37.58	2.68 *
	SD	10.81	13.40	
	n	19	19	

* $p < .05$. ** $p < .01$.

Table 8

Comparison of Posttest Scores for the Field Sites

	SS	MS	df	F
Covariate	8067.49	2067.49	1	133.60
Treatment	7705.77	1284.33	6	21.27 *
Error	7367.16	60.39	122	----
Total	23140.62	179.39	129.00	----

* $p < .01$.

Table 9

Scheffe Comparisons among Means for the Field Sites

CLASS	1	2	3	4	5	6	7
1	---	14.63 *	26.58 *	27.92 *	0.0007	0.2969	12.27
2	---	---	0.3974	60.38 *	14.97 *	17.61 *	41.81 *
3	---	---	---	87.42 *	27.25 *	30.76 *	65.35 *
4	---	---	---	---	28.10 *	22.35 *	4.19
5	---	---	---	---	---	0.2743	12.40
6	---	---	---	---	---	---	8.55

* $p < .05$.

DISCUSSION

The primary purpose of the project was to evaluate the effect of the Mastering Fractions videodisc program on student achievement outcomes. A secondary purpose was to evaluate student and teacher attitudes toward this instructional program and medium. The evaluation was conducted in two parts. Part 1 was a controlled study that examined the effectiveness of the program with and without the benefit of the videodisc medium. Part 2 was a simple descriptive study that examined the effects of using the Mastering Fractions videodisc program in non-experimentally controlled classroom environments. From the results of these studies a number of conclusions and implications can be drawn.

Achievement Outcomes

The results of the two-part evaluation support several conclusions concerning student achievement outcomes. First, the use of Mastering Fractions videodisc program resulted in statistically significant pretest to posttest gains in all classes participating in the study. However, the magnitude of the gains and the percent of correct responses on the posttest measure varied across classes. It should be noted that the largest pre-post gains and percent correct on the posttest were

found in classes where all 35 of the Mastering Fractions lessons and tests were completed within an eight week period. Several reasons could be posited for this finding. One is that the daily use of the program resulted in greater mastery of the concepts since the massed instruction allowed students to practice and use newly learned concepts before they were forgotten.

In the classes where the use of the Mastering Fractions program was spread over a longer period of time the pre-post gains and percent correct on the posttest were much lower. For example, of the seven field site classes, the two classes with the lowest mastery scores also had the longest implementation periods. The class that completed only 25 lessons in 51 school days averaged only 42% correct on the posttest. It is not surprising that this class scored lower on the posttest since only 25 lessons were completed. However, when comparing this class to the two classes in the experimental study that also completed only 25 lessons, there was a wide discrepancy on the posttest scores. These two classes averaged 74% correct on the posttest but it should be noted that they completed the 25 lessons in a much shorter period of time (38 days). Finally, in the field site class that took the longest to complete all 35 lessons (73 school days), the students only averaged 60% correct on the posttest. Thus, it would appear that consistency of use is a necessary condition for gaining maximum benefit from the

Mastering Fractions program.

A second possible explanation for why the greatest gains were found in classes where Mastering Fractions was used consistently is that perhaps these teachers were simply more dedicated and better teachers. This would suggest that the Mastering Fractions program is not teacher proof. Even though the instructional content of the program is held constant through the videodisc medium, if teachers fail to use the program in the prescribed manner then the benefits of the program are weakened. It is possible that the relationship that we found between higher mastery scores and that consistent use of the program is an artifact of good teaching. Since research on effective teaching shows that good teachers are more organized, it is possible that consistency of use is simply a measure of organization and structure. Nevertheless, the data suggest that even when the program was implemented poorly, students made statistically significant gains, but the greatest gains were found in the classes where the program was implemented as designed.

Although all classes receiving the Mastering Fractions Program showed significant achievement gains, one rival hypothesis is that these gains were a result of a novelty effect produced by the videodisc medium. The results from Part 1 of this evaluation suggest that this rival hypothesis should be rejected. The posttest scores comparing the Mastering Fractions

Videodisc and Teacher conditions in the experimental study showed no significant differences between the two groups. Thus, the results suggest that any student gains should be attributed to the instructional content and methodology of the instructional program and not to the medium itself.

It is important here, however, to point out that the discussion above does not suggest that the videodisc medium is not important to the Mastering Fractions program. On the contrary, it would be virtually impossible to produce across the board student gains without the use of the videodisc medium. The videodisc medium provides educators with the ability to capture high quality interactive instructional sequences that can be easily transported from classroom to classroom without a resultant degradation in the quality of instruction.

If teachers were to replicate the instruction used by the Mastering Fractions Teacher treatment, first they would have to be trained in the content and methodology of the Mastering Fractions program. Second, they would have to be extremely careful so as not to change the content and methodology from presentation to presentation and year to year. With Mastering Fractions this is not a problem since the instructional content and methodology is built into the videodisc and is unalterable. By combining the sound instructional content and methodology of the Mastering Fractions program with the videodisc medium the

result is a robust instructional package that is transportable from classroom to classroom. If used as designed, the Mastering Fractions videodisc program provides teachers with an effective and motivating tool for presenting an extensive fractions curriculum.

Although data from this evaluation show that the use of the Mastering Fractions program results in statistically significant pre to posttest gains, it could be hypothesized that these gains would have occurred without the use of the Mastering Fractions program. However, data from Part 1 of this evaluation cause this hypothesis to be rejected. Here, the Mastering Fractions Videodisc and Teacher conditions were compared to an alternative fractions curriculum. The results of these comparisons indicated that students receiving the Mastering Fractions treatments (Video and Teacher) scored significantly higher on the posttest than did students receiving the alternate curriculum. The most significant aspect of this finding is that even though the average-ability groups receiving the Mastering Fractions treatments received only 25 of the 35 lessons, these students still scored significantly higher on the posttest than even the high-ability group that received the alternate fractions curriculum. This finding would suggest that when used correctly, even receiving a portion of the Mastering Fractions program could be more beneficial to students than existing fractions instruction.

Teacher and Student Perceptions

Following the implementation of the Mastering Fractions program in the experimental and field sites, all of the participating teachers and a sample of students were interviewed and asked questions pertaining to their perceptions and feelings about the Mastering Fractions program. As with any qualitative data set the analysis is difficult. Nevertheless, a number of consistent remarks concerning the Mastering Fractions program seemed to emerge from the interviews. Following a summary from these interview data.

Teacher interviews. When asked about the difficulty in operating the videodisc player, all of the teachers in the study said that it was either "easy", or "moderately easy" to operate. The only difficulty reported was that sometimes pressing the PLAY button instead of the STEP button on the remote control caused the program to fast forward which required a few extra minutes to find the appropriate place in the program again.

When asked how the Mastering Fractions program was useful as a teaching tool the responses included:

"It presented material in a way that was interesting to the students. It allowed the students to visualize the concepts they were learning."

"The videodisc presented material slowly and with reinforcement so it was easy for the children to learn."

"The sound effects and movement were always changing so it kept the students attention."

"Almost all of the students did more work than normal. They responded well to the disc, and their grades improved considerably."

When questioned about any negative aspects of the program the teachers all agreed that there were only a few negative aspects. Some that were reported included:

"The program did not emphasize simplification nearly enough to satisfy CAT requirements."

"The students become bored with the copying of problems from the video screen."

"I would shorten some of the lessons that were more repetitive and sometimes present more than one per day."

"The students became frustrated with the darkened answer boxes and not enough room to do computations in the workbook."

When the teachers were questioned on how their students liked the Mastering Fractions program, the common response from all of the teachers was that the students liked the program more at the beginning than at the end. However, one teacher said:

"Now that the program is over they ask everyday when we will be able to use the disc player again."

One comment that seems to typify how the teachers felt about the Mastering Fractions program was:

"I loved being able to access a disc. The fractions program was well thought out and used sound teaching concepts. The

problem is that we 'human-type teachers' like to do things our way and we are all different. I would prefer to integrate the use of the disc in with my regular program and not use it in a canned approach."

Student interviews. When asked what they liked most about the Mastering Fractions program the students gave a variety of answers. All had positive comments about the program. Some of the most common responses included:

"Starts easy and reviews then goes on to the harder lessons."

"The tests and reviews were easy."

"Explains the problems well and gives lots of practice."

"Received great grades."

"Made fractions much easier to understand."

"Talked about the problems and showed pictures of the fractions, didn't just give assignment with no instructions."

"The animation was very good."

"Easy to understand."

When asked what they liked least about the program, the most common response was that by lesson 25 or 30 they began getting tired of doing fractions. Some of the comments were:

"After a while there were too many reviews."

"The quizzes were long and we had to do them even if we were getting 100% correct each time."

"Didn't progress as fast as regular math, had too many quizzes."

Even though the students said that they tired of the program, when asked how much they learned about fractions, 90% of them responded with, "a lot", or "more than I expected." Thus, they felt that they were learning from the program.

Further when asked if the Mastering Fractions program was a "good teacher," every student interviewed responded with a "yes." When asked why they felt that way, the general responses were:

"The program made it easy to pay attention, it was more interesting."

"The program taught with pictures and graphs which made it more interesting."

"Explained it more than the teacher does, easier to understand."

"It gave examples and showed you how to do the problems before giving you assignments."

"The program adds-on from past lessons."

When asked, "If you had a choice as to how you would learn fractions, what would it be?", three-fourths said that they would like to use the Mastering Fractions program and the remaining one-fourth said they would like to learn fractions on a computer. None of the students said that they would like to learn from a teacher.

When asked how they would make the program better, a variety of comments were given, they included:

"Cut out some of the reviews and introduce the short ways to do the problems."

"We already knew the short ways and to go back to the long ways was a pain."

These comments were especially interesting in that the Mastering Fractions program avoids teaching "short cuts" since it is often the short cuts that cause students the greatest difficulty when they move into algebra. Often the short cuts that they have learned are conceptually inaccurate and lead to misunderstanding in higher level math courses.

Other comments on how to improve the program included:

"Make the questions harder."

"Would take out the reviews."

"Change the pace, make it go faster."

Finally, when asked what their feelings about this experience were, the general responses included:

"Would like to learn other subjects from the videodisc."

"Liked the disc, something new and different."

"Bored with the disc or the program, maybe another subject would be better."

"Looked forward to using the videodisc each day."

"The program was more fun than regular class."

"Left yawning."

"Liked it much better than regular books and class."

The overall response of the students who were interviewed was quite positive. In the interviews it was clear that the students felt that they had learned a great deal from the program. When asked how they knew they had learned something they usually responded with, "I did well on the quizzes and the tests." The only complaint from the students was that they grew tired of the program toward the end. However, a number of students stated that they would enjoy other subjects being presented on videodisc which would indicate that they were just tired of learning about fractions and not of the videodisc medium.

Summary

The results of the evaluation suggest that the Mastering Fractions program, when used as designed, is a powerful instructional tool for the teaching fractions concepts and skills to students exhibiting a wide range of ages and abilities. It appears from this evaluation that the effectiveness of Mastering Fractions, like other instructional programs, is somewhat dependent upon the commitment and quality of the teacher using the materials. In other words, the program does not appear to be teacher-proof.

The results of the evaluation further suggest that the

achievement gains attributed to the use of the Mastering Fractions program are a result of the instructional content and methodology underlying the program and are not attributed to a novelty effect of the videodisc medium. Thus, when used appropriately, one should expect for students to attain the instructional objectives as outlined in Mastering Fractions program.

Finally, it would appear that the Mastering Fractions program is regarded highly by teachers and students. Teachers find the program easy to implement and the technology to be friendly and not difficult to operate. Further, they report that the program is instructionally sound and highly motivating to students. Similarly, students report that they enjoyed using the Mastering Fractions program, that they felt that they learned a great deal from the program, and that would recommend the use of Mastering Fractions with other students.

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APPENDIX A

Introduction to Interactive Videodisc

An Overview of Videodisc Technology

A stand alone, optical scan, videodisc system consists of a videodisc player, a color monitor, and a prerecorded videodisc. The videodisc player uses a low-powered laser beam to scan and decode the video and audio information that is stored on the surface of the disc.

Today's videodisc systems are optical systems which allows the reading of information from the disc without physical contact, thereby eliminating wear on the disc. The videodisc resembles a shiny metallic long-playing record album without visible grooves. The disc rotates in the player at the speed of 1800 rpm. The videodisc player uses a laser beam to read the information stored on the disc. As the disc rotates, a low-powered laser is directed onto the disc surface and the intensity of the laser light is modulated by billions of microscopic pits etched on the disc surface. As the light is reflected off of the surface a sensor transforms the modulated light into visual signals that are then displayed on the video monitor.

A videodisc can store the same information as a videotape, but the disc is a random access medium. Information can be stored in each of the 54,000 individual frames found on each side of a videodisc. This capacity is equivalent to 675 trays of 35mm slides, or a 1/2 hour motion picture film. The player can randomly access any information on the disc in about three

seconds or less. Information can take several forms. For example, movies, still pictures, or text can be placed on a videodisc medium.

The videodisc is an extremely durable and robust medium. The surface of the disc is coated with a thin clear plastic to protect it from dirt and scratches. Since nothing except the laser light touches the disc surface during information retrieval, the disc does not wear out. The optical disc player supports such advanced features as random frame access, freeze frame, reverse, variable speeds, stereo sound, and can be programmed to operate with a computer.

Levels of Interactivity

A classification system that describes the level of interactivity of various videodisc configurations was proposed by the Nebraska Videodisc Design and Production Group in 1979 (Daynes, 1984). This classification system is based on the "intelligence" levels of different systems. The initial classification scheme included Levels 0 through 3. Recently, a fourth level has been added. They are as follows:

Level 0 - This system consists of a linear player. Designed primarily for home entertainment, the system has limited interactive functions.

Level 1 - The features of a Level 1 player include quick frame access, freeze frame and scanning functions, two user

selectable audio channels and chapter and picture stops. These features are controlled manually through a remote control device, thus allowing the user to stop the disc, scan forward or backward, jump to specific frames, and to freeze images. For a more complete description of the features included in a Level 1 videodisc system, the reader is referred to Hoffmeister, Engelmann, and Carnine (1986). Level 2 - The Level 2 player is equipped with an internal microprocessor that adds intelligence to the Level 1 functions. The computer program that controls the presentation resides on the disc audio track and is loaded from the disc to the microprocessor. The user indicates answers to questions or makes choices through the remote control device used for controlling the disc player. The player responds by branching to different disc segments depending upon the logic of the computer program. This level of interaction is limited by the amount of memory in the microprocessor and by the fact that the computer program can not be altered once it has been placed on the disc.

Level 3 - Systems at this level consist of a Level 1 or Level 2 player linked to a microcomputer. This configuration allows both computer and videodisc-generated material to be shown on the screen. Branching is controlled by computer software. Because the presentation is driven by the microcomputer a variety of input devices including the computer keyboard, joystick, light pen, and touch screen, can be used. Additionally responses can be recorded using the computer's external storage devices.

Level 4 - A Level 4 system is distinguished from a Level 3 system by the additional power of the microcomputer software. If some type of artificial intelligence software is used, it is usually classified as a Level 4 system.

APPENDIX B
Pre - Posttest

Name _____ Teacher _____

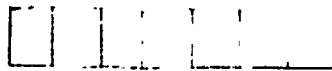
1. Circle the numerator of each of these fractions. $\frac{3}{4}$ $\frac{10}{5}$ $\frac{1}{3}$

2. Circle the denominator of each of these fractions. $\frac{1}{7}$ $\frac{5}{8}$ $\frac{21}{2}$

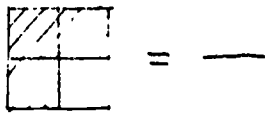
3. Shade $\frac{2}{3}$ of this shape.



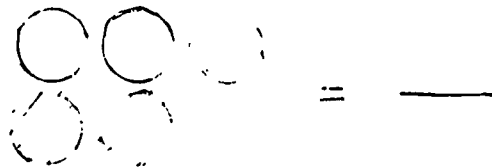
4. Shade $\frac{4}{7}$ of this shape.



5. Write the fraction that tells which part is shaded in the pictures below.



= —



= —

6. Circle the fractions below that are greater than one whole.

$\frac{3}{4}$ $\frac{7}{5}$ $\frac{12}{6}$ $\frac{2}{3}$ $\frac{9}{2}$ $\frac{10}{3}$

7. Circle the fractions below that are less than one whole.

$\frac{7}{3}$ $\frac{1}{6}$ $\frac{10}{6}$ $\frac{4}{3}$ $\frac{3}{5}$ $\frac{4}{4}$

8. Circle the fractions below that are equal to one whole.

$\frac{1}{4}$ $\frac{10}{9}$ $\frac{1}{3}$ $\frac{9}{7}$ $\frac{3}{7}$ $\frac{8}{8}$

9. Write in the missing number to complete the fractions.

$$3 = \frac{\quad}{5}$$

$$\frac{\quad}{2} = 8$$

$$5 = \frac{\quad}{6}$$

$$\frac{\quad}{8} = 3$$

10. Write the fraction that names the X on the number line below.



11. Write the equivalent fractions for the problems below.

$$\frac{6}{1} = \underline{\quad} \quad \frac{4}{5} = \frac{\quad}{20} \quad \underline{\quad} = \frac{40}{7} \quad \frac{6}{7} = \frac{\quad}{51}$$

12. Write the first common number for the set of numbers.

a) 4, 3,

b) 6, 2, 9,

13. Write the first common numbers for the denominators below.

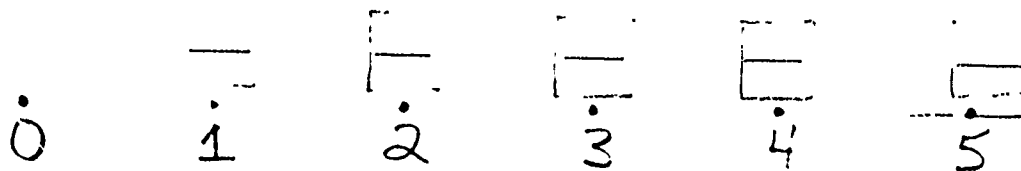
$$\frac{4}{6}, \frac{2}{4}, \frac{1}{2} \quad \underline{\hspace{2cm}} \quad \frac{3}{4}, \frac{2}{10} \quad \underline{\hspace{2cm}}$$

14. Write the fractions in order by size from the smallest to the largest.

$$\frac{4}{8}, \frac{1}{8}, \frac{8}{8}, \frac{5}{8} \quad \underline{\hspace{2cm}} \quad \underline{\hspace{2cm}} \quad \underline{\hspace{2cm}} \quad \underline{\hspace{2cm}}$$

$$\frac{1}{1}, \frac{3}{4}, \frac{1}{5}, \frac{2}{3} \quad \underline{\hspace{2cm}} \quad \underline{\hspace{2cm}} \quad \underline{\hspace{2cm}} \quad \underline{\hspace{2cm}}$$

15. Write the fraction for each whole number on the number line below.



16. Mark an X where $\frac{3}{2}$ should be on the number line ABOVE.

17. Write the fractions below as mixed numbers.

$$\frac{7}{3} = \quad \frac{10}{6} = \quad \frac{8}{2} = \quad \frac{10}{3} =$$

18. Simplify the fractions below.

$$\frac{17}{3} = \quad \frac{4}{12} = \quad \frac{3}{2} = \quad 5 \frac{12}{15} =$$

19. Write the answer for each multiplication problem below.

$$\frac{4}{3} \times \frac{2}{4} = \quad 5 \times \frac{1}{4} = \quad \frac{1}{2} \times \frac{9}{8} \times \frac{1}{4} = \quad 1 \frac{1}{2} \times 1 \frac{3}{4} =$$

20. Use addition to answer the problems below.

$$5 + \frac{5}{8} = \quad \frac{1}{3} + 2 \frac{1}{3} + \frac{2}{6} = \quad \begin{array}{r} 7 \\ 6 \\ + 3 \\ \hline \end{array} \quad \begin{array}{r} \frac{1}{4} \\ \frac{4}{4} \\ \frac{5}{5} \\ \frac{2}{2} \\ + \frac{2}{4} \\ \hline \end{array}$$

21. Subtract the fractions below.

$$4 - 1 \frac{1}{3} = \quad 10 \frac{2}{5} - 3 \frac{1}{6} = \quad \begin{array}{r} 5 \\ - \frac{3}{4} \\ \hline \end{array} \quad \begin{array}{r} \frac{6}{8} \\ - \frac{3}{8} \\ \hline \end{array}$$

22. Write the mixed numbers below as fractions.

$$2 \frac{4}{7} = \quad 6 \frac{1}{3} = \quad 3 \frac{3}{4} = \quad 1 \frac{6}{9} =$$

23. Write each fraction as a division problem then write the answer.

$$\frac{38}{10} = \quad \frac{18}{4} =$$

24. Write the answers for the problems below.

$$\frac{8}{3} \div 2 \frac{2}{3} = \quad \frac{3}{8} \div \frac{1}{2} =$$

APPENDIX C
Mastery Tests

Lesson 5

Review Test

NAME _____

Part A

Copy each fraction. Write more than one, equals one, or less than one.

① $\frac{6}{1}$

⑤ $\frac{9}{9}$

② $\frac{1}{9}$

⑥ $\frac{6}{6}$

③ $\frac{1}{6}$



⑦ $\frac{5}{5}$

④ $\frac{4}{5}$



⑧ $\frac{5}{1}$

Part B

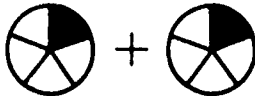
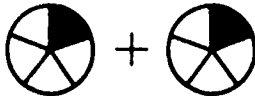
Write the fraction for each picture. Write the fraction for the total. Remember the signs.

①  + 

$\boxed{\quad} + \boxed{\quad} = \boxed{\quad}$

③  + 

$\boxed{\quad} + \boxed{\quad} = \boxed{\quad}$

②  + 

$\boxed{\quad} + \boxed{\quad} = \boxed{\quad}$

Part C*Copy each problem. Multiply and write the answer.*

① $\boxed{\quad} = \frac{2}{5} (3)$

⑤ $\frac{7}{5} \times \frac{3}{1} = \boxed{\quad}$

② $\frac{1}{5} \times \frac{1}{7} = \boxed{\quad}$

⑥ $\frac{3}{4} \times \frac{4}{2} = \boxed{\quad}$

③ $\boxed{\quad} = \frac{9}{3} \times \frac{2}{5}$

⑦ $\boxed{\quad} = 8 \times \frac{1}{3}$

④ $(2) \frac{3}{5} = \boxed{\quad}$

⑧ $\boxed{\quad} = \frac{1}{5} (5)$

Part D*Copy each equation and write the missing number.*

① $\frac{4}{4} = \boxed{\quad}$

④ $\boxed{\quad} = \frac{300}{300}$

② $\boxed{\quad} = \frac{7}{1}$

⑤ $\frac{3}{1} = \boxed{\quad}$

③ $\boxed{\quad} = \frac{200}{1}$

⑥ $\frac{3}{3} = \boxed{\quad}$

Part E

- ① Write the fraction that equals one and has 100 on the top.
- ② Write the fraction that equals one and has 5 on the bottom.
- ③ Write the fraction that equals one and has 4 on the bottom.

Lesson 10

Review Test

NAME _____

Part A

Copy each equation and complete it.

① $\frac{650}{650} = \square$

③ $\frac{400}{1} = \square$

⑤ $1 = \frac{600}{\square}$

② $1 = \frac{1}{3}$
 \square

④ $\frac{5}{8} = 1$
 \square

⑥ $\frac{2}{5} = \frac{2}{5}$
 \square

Part B

Copy each equation and complete it.

① $\frac{90}{10} = \square$

③ $\square = \frac{25}{5}$

② $\frac{21}{7} = \square$

④ $\square = \frac{12}{6}$

Part C

Copy each fraction that equals 3.

① $\frac{18}{6}$

③ $\frac{6}{3}$

⑤ $\frac{12}{4}$

⑦ $\frac{15}{3}$

② $\frac{6}{18}$

④ $\frac{3}{1}$

⑥ $\frac{3}{9}$

Part D

Copy each problem that can be worked the way it is written. Then work it.

$$\textcircled{1} \frac{3}{1} \times \frac{3}{5} = \boxed{\quad}$$

$$\textcircled{5} \frac{5}{1} - \frac{1}{5} = \boxed{\quad}$$

$$\textcircled{2} \frac{2}{1} + \frac{2}{1} = \boxed{\quad}$$

$$\textcircled{6} \frac{3}{5} \times \frac{3}{1} = \boxed{\quad}$$

$$\textcircled{3} 2 - \frac{1}{2} = \boxed{\quad}$$

$$\textcircled{7} \frac{3}{8} + \frac{8}{8} = \boxed{\quad}$$

$$\textcircled{4} \frac{1}{5} \times \frac{1}{5} = \boxed{\quad}$$

$$\textcircled{8} \frac{10}{3} - \frac{2}{3} = \boxed{\quad}$$

Part E

Copy each fraction and write: more than one, equals one or less than one.

$$\textcircled{1} \frac{2}{3}$$

$$\textcircled{3} \frac{5}{1}$$

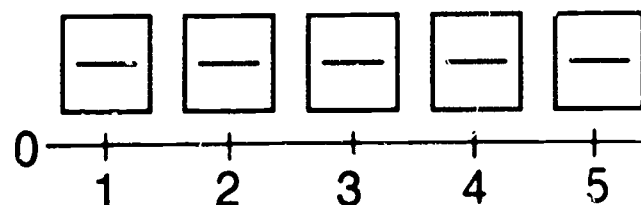
$$\textcircled{2} \frac{5}{4}$$

$$\textcircled{4} \frac{2}{5}$$

Part F

We want to put this fraction on a number line: $\frac{6}{4}$

Copy the number line and write the fraction for each whole number.



Lesson 15

Review Test

NAME _____

Part A

Write each fraction as a division problem and then write what it equals.

① $\frac{31}{3}$

② $\frac{27}{10}$

③ $\frac{29}{4}$

④ $\frac{15}{4}$

Part B

- ① Write the first common number for 9 and 7.
- ② Write the first common number for 2, 10 and 4.
- ③ Write the first common number for 8 and 2.
- ④ Write the first common number for 3, 6 and 4.

Part C

Copy each equation. Write the whole number as a simple fraction. Then complete the fraction that the whole number equals.

① $2 = \frac{\blacksquare}{7}$

② $\frac{\blacksquare}{3} = 9$

③ $4 = \frac{\blacksquare}{6}$

④ $\frac{\blacksquare}{4} = 3$

Part D

Copy each equation and write the answer. Then make the picture for each fraction.

① $\frac{2}{4} \times \frac{2}{2} = \blacksquare$

② $\frac{2}{3} \times \frac{2}{2} = \blacksquare$



Part E

Copy each problem that can be worked the way it is written and work it.

$$\begin{array}{r} \textcircled{1} \quad \frac{3}{4} \\ + \frac{5}{3} \\ \hline \square \end{array}$$

$$\begin{array}{r} \textcircled{2} \quad \frac{7}{8} \\ - \frac{3}{8} \\ \hline \square \end{array}$$

$$\begin{array}{r} \textcircled{3} \quad \frac{7}{4} \\ - \frac{7}{5} \\ \hline \square \end{array}$$

$$\begin{array}{r} \textcircled{4} \quad 4 \\ - \frac{2}{4} \\ \hline \square \end{array}$$

$$\begin{array}{r} \textcircled{5} \quad \frac{11}{6} \\ + \frac{6}{6} \\ \hline \square \end{array}$$

Lesson 20

Review Test

NAME _____

Part A

Copy each equation and write the missing numbers.

$$\textcircled{1} \frac{3}{4} \left(\quad \right) = \frac{\square}{20}$$

$$\textcircled{3} \frac{1}{2} \left(\quad \right) = \frac{\square}{12}$$

$$\textcircled{2} \frac{2}{3} \left(\quad \right) = \frac{\square}{21}$$

$$\textcircled{4} \frac{5}{6} \left(\quad \right) = \frac{\square}{18}$$

Part B

For each problem, write the first common number for the denominators.

$$\textcircled{1} \frac{1}{2}$$
$$\frac{1}{4}$$
$$\frac{5}{6}$$

$$\textcircled{3} \frac{2}{5}$$
$$\frac{2}{7}$$

$$\textcircled{2} \frac{3}{4}$$
$$\frac{1}{8}$$

$$\textcircled{4} \frac{3}{4}$$
$$\frac{7}{10}$$

Part C

For each problem, write a second equation with the fraction for the whole number. Work the equation.

$$\textcircled{1} \quad 3 - \frac{2}{5} = \boxed{\quad}$$

—	—	—
---	---	---

$$\textcircled{3} \quad 2 + \frac{9}{8} = \boxed{\quad}$$

—	—	—
---	---	---

$$\textcircled{2} \quad \frac{12}{7} - 1 = \boxed{\quad}$$

—	—	—
---	---	---

$$\textcircled{4} \quad \frac{3}{4} + 1 = \boxed{\quad}$$

—	—	—
---	---	---

Part D

For each problem, write a second equation with the fraction for the whole number. Work the equation.

$$\textcircled{1} \quad 4 \times \frac{2}{3} = \boxed{\quad}$$

—	—	—
---	---	---

$$\textcircled{3} \quad \frac{12}{5} - 2 = \boxed{\quad}$$

—	—	—
---	---	---

$$\textcircled{2} \quad 3 + \frac{5}{3} = \boxed{\quad}$$

—	—	—
---	---	---

$$\textcircled{4} \quad \frac{3}{4} \times 2 = \boxed{\quad}$$

—	—	—
---	---	---

Lesson 25

Review Test

Part A

Copy these problems and work them.

$$\begin{array}{r} \textcircled{1} \quad \frac{2}{3} \\ - \frac{2}{9} \\ \hline \square \\ \hline \square \end{array}$$

$$\begin{array}{r} \textcircled{2} \quad \frac{3}{10} \\ + \frac{1}{5} \\ \hline \square \\ \hline \square \end{array}$$

$$\begin{array}{r} \textcircled{3} \quad \frac{3}{4} \\ - \frac{1}{8} \\ \hline \square \\ \hline \square \end{array}$$

Part B

Copy these problems and work them.

$$\begin{array}{r} \textcircled{1} \quad \frac{3}{4} \\ + 2 \\ \hline \square \\ \hline \square \end{array}$$

$$\begin{array}{r} \textcircled{2} \quad 4 \\ - \frac{2}{3} \\ \hline \square \\ \hline \square \end{array}$$

$$\begin{array}{r} \textcircled{3} \quad \frac{6}{5} \\ + 1 \\ \hline \square \\ \hline \square \end{array}$$

Part C*Copy these problems and work them.*

$$\begin{array}{r} \textcircled{1} \quad \frac{1}{3} \\ \frac{3}{4} \\ + \frac{1}{2} \\ \hline \square \\ \hline \square \end{array}$$

$$\begin{array}{r} \textcircled{2} \quad \frac{3}{1} \\ \frac{1}{2} \\ + \frac{1}{4} \\ \hline \square \\ \hline \square \end{array}$$

$$\begin{array}{r} \textcircled{3} \quad \frac{2}{5} \\ \frac{1}{2} \\ + \frac{3}{10} \\ \hline \square \\ \hline \square \end{array}$$

Part D*Copy each problem and work it. Write common-denominator problems in a column.*

$$\textcircled{1} \quad \frac{3}{4} \times \frac{2}{4} = \square$$

$$\textcircled{2} \quad 3 + \frac{5}{3} = \square$$

$$\textcircled{3} \quad 4 - \frac{4}{7} = \square$$

Part E*Copy these equations. Write the correct fraction of one and then write the missing number.*

$$\textcircled{1} \quad \frac{\square}{6} \left(\quad \right) = \frac{10}{12}$$

$$\textcircled{2} \quad \frac{4}{\square} \left(\quad \right) = \frac{16}{20}$$

$$\textcircled{3} \quad \frac{\square}{3} \left(\quad \right) = \frac{10}{15}$$

Part F*Copy each problem. Write the mixed number with a + sign. Add and write the fraction you get.*

$$\textcircled{1} \quad 2 \frac{2}{3}$$

$$\textcircled{2} \quad 3 \frac{1}{5}$$

$$\textcircled{3} \quad 1 \frac{7}{8}$$

Part G*Write the complete equations. Write your answer as a number over 1 or 1 over a number.*

$$\textcircled{1} \quad \frac{4}{20}$$

$$\textcircled{2} \quad \frac{18}{6}$$

$$\textcircled{3} \quad \frac{7}{14}$$

Lesson 30

Review Test

NAME _____

Part A

Copy each problem. Below, write the multiplication equation with the answer.

$$\textcircled{1} \frac{4}{5} \div \frac{1}{4} = \boxed{\quad}$$

$$\textcircled{3} \frac{3}{7} \div \frac{3}{2} = \boxed{\quad}$$

$$\textcircled{2} 5 \div \frac{3}{7} = \boxed{\quad}$$

Part B

Copy each mixed number and write it as a fraction.

$$\textcircled{1} 1 \frac{3}{5}$$

$$\textcircled{2} 7 \frac{2}{3}$$

$$\textcircled{3} 4 \frac{1}{6}$$

Part C

Copy these fractions and simplify them.

$$\textcircled{1} \frac{12}{28}$$

$$\textcircled{2} \frac{8}{10}$$

$$\textcircled{3} \frac{15}{40}$$

Lesson 35

Review Test

NAME _____

Copy each problem and work it. Simplify each answer if you can.

$$\textcircled{1} \frac{7}{2} \div 2 \frac{1}{2} = \blacksquare$$

$$\textcircled{10} 2 \frac{1}{4} \times 1 \frac{1}{5} = \blacksquare$$

$$\textcircled{2} \frac{1}{3} + \frac{1}{4} + \frac{1}{6} = \blacksquare$$

$$\textcircled{11} 1 \frac{1}{4} \div 5 = \blacksquare$$

$$\textcircled{3} \frac{5}{7} - \frac{1}{3} = \blacksquare$$

$$\textcircled{12} 3 - \frac{3}{4} = \blacksquare$$

$$\textcircled{4} \frac{7}{10} + 1 \frac{1}{4} = \blacksquare$$

$$\textcircled{13} \frac{3}{8} \div \frac{1}{2} = \blacksquare$$

$$\textcircled{5} 1 \frac{1}{2} \times 1 \frac{3}{4} = \blacksquare$$

$$\textcircled{14} \frac{5}{9} - \frac{1}{2} = \blacksquare$$

$$\textcircled{6} \frac{3}{5} \div 5 = \blacksquare$$

$$\textcircled{15} 4 \times 1 \frac{5}{6} = \blacksquare$$

$$\textcircled{7} \frac{2}{3} + 3 + \frac{1}{2} = \blacksquare$$

$$\textcircled{16} 2 \frac{1}{3} - 1 \frac{4}{5} = \blacksquare$$

$$\textcircled{8} 3 \times 1 \frac{1}{3} = \blacksquare$$

$$\textcircled{17} \frac{3}{4} + 1 \frac{1}{2} + 2 = \blacksquare$$

$$\textcircled{9} \frac{1}{5} + \frac{1}{3} + \frac{1}{2} = \blacksquare$$

APPENDIX D
Teacher Logs

Week of <u> </u> / <u> </u> / <u> </u> to <u> </u> / <u> </u> / <u> </u>	Monday Lesson <u> </u> <u> </u>	Tuesday Lesson <u> </u> <u> </u>	Wednesday Lesson <u> </u> <u> </u>	Thursday Lesson <u> </u> <u> </u>	Friday Lesson <u> </u> <u> </u>
How many minutes did you spend preparing for this lesson?					
How many minutes did you spend grading previous homework?					
How many minutes did it take to complete today's lesson?					
If used, comment on the effectiveness of the remediation in today's lesson.					
Could you improve the workbook activities for today's lesson, if so, how?					
Could you improve the content and sequence of today's lesson, if so, how?					
Comment on the students' reaction to today's lesson.					
What are your feelings about the success of today's lesson?					
Other comments					

APPENDIX E

Teacher Structured Interview Questions

Teacher Interview Questions

The videodisc player was:

- ☐ very difficult to use
- ☐ difficult to use
- ☐ slightly difficult to use
- ☐ easy to use.

The Mastering Fractions Program was :

Easy to use because:

Difficult to use because:

Helpful to me as a teacher because:

Not helpful to me as a teacher because:

Helpful to the students because:

Not helpful for the students because:

Instrumental in keeping the student's attention because:

Distracting to the students because:

Similar to your regular fractions curriculum in that:

Different from your regular fractions curriculum in that:

If you had a choice would you:

- ☐ substitute Mastering Fractions for your regular curriculum
- ☐ combine Mastering Fractions with your regular curriculum
- ☐ not use the Mastering Fractions program

Would you change any parts of this program, if so, which parts?

Did the classroom atmosphere change while using the Mastering Fractions program, if so, how?

How do your students like the program?

At what grade level would this program be best suited; and what type of students would benefit most from this program?

APPENDIX F

Student Structured Interview Questions

STUDENT INTERVIEW QUESTIONS

NAME _____

AGE _____ GRADE _____ Teacher _____

What did you like most about Mastering Fractions?

What do you like least about Mastering Fractions?

How much did you learn about fractions:

___ not much ___ a little ___ about what I expected

___ more than I expected ___ a lot

The pace of the lessons were:

___ slow ___ a little slow ___ about right

___ a little to fast ___ much to fast

Was the video laser disc program a good teacher?

___ Yes ___ No Why?

The homework problems were:

___ easy ___ about right ___ hard

How well do you think your teacher liked the Mastering Fractions Program?

Would you rather learn this week's fraction lessons from:

___ a regular Math text book.

___ a computer

___ Mastering Fractions

___ worksheets and the blackboard

What would you do to make this program better?

Do you think that other students would enjoy learning fractions using the Mastering Fractions program?